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ABSTRACT

Research into the influence of a context sentence on the processing of a subsequent sentence in spoken discourse examined two issues: (1) whether context influences the immediate processing and organization of a subsequent clause, and (2) whether listeners make certain types of context-based inferences prior to the end of a sentence. Three experiments were conducted involving a total of 98 college stuents. The first and second experiments demonstrated that clauses with pronouns become better processing units in contexts that provide a referential antecedent for the pronoun. The third experiment demonstrated that listeners begin to make inferences necessary to construct an antecedent for a definite noun phrase prior to the end of a clause or sentence. The results suggest that there is not an initial point in the comprehension process at which the listener's representation of what has been heard is restricted to information of the type provided by the context-independent description posited by most grammars. The findings further suggest that the initial processing and representation of a sentence in discourse may differ from those of the same sentence in isolation. (FL)

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Technical Report No. 176

DISCOURSE CONTEXT AND SENTENCE PERCEPTION

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Abstract

Three experiments investigated the influence of a context sentence on the processing of a subsequent sentence. Experiments 1 and 2 demonstrated that clauses with pronoun subjects functioned as processing units only when preceded by a context sentence that established a referent for the pronoun. Experiment 3 suggested that listeners make inferences which link definite noun phrases to a preceding context as soon as the definite noun phrase is encountered. The results suggest that context can affect within-sentence processes in comprehension.

Discourse Context and Sentence Perception

Although many psycholinguists have recently turned their attention to questions related to discourse, most research on language comprehension has focused on the processes by which listeners understand single sentences (see Levelt, 1978, for review). The reasons for this emphasis on the sentence as the object of inquiry are probably largely historical, since at the time this research was initiated, the dominant linguistic theory, transformational generative grammar, provided a rich analysis of sentence structure. A great deal of early psycholinguistic research attempted to test the psychological reality of various aspects of transformational grammar. While attempts to directly incorporate transformational grammars into models of language comprehension were soon abandoned, much research has continued to be guided by the assumption that at some point in the comprehension process, the listener understands a sentence in terms of a representation isomorphic with its linguistic deep structure (see Fodor, Bever, & Garrett, 1974; Fodor, Fodor, & Garrett, 1975). For example, Fodor, Fodor, and Garrett (1975) argue,

> It seems that any psychological model of such [communication] exchanges must recognize some formal object which captures the notion of the message standardly communicated by uttering a sentence. The view we are considering here--which, in fact, we endorse--requires that this object be among the structural descriptions that the grammar assigns to the sentence. (p. 516)

This assumption is incorporated into the clausal model of sentence perception proposed by Fodor, Bever, and Garrett (1974) which integrates much of the sentence perception literature of the 1960's and early 1970's. The clausal model proposes that syntactically well-formed clauses (which correspond to deep structure sentences in standard theory) are the primary processing units in sentence perception. As a clause is heard, the listener uses perceptual mapping rules or strategies (Bever, 1970) to develop potential representations of the clause by mapping each word onto its deep structure role. Once the clause ends, it is recoded into a more abstract form which frees limited capacity resources to process subsequent input (Bever, Garrett, & Hurtig, 1973; Fodor, Bever, & Garrett, 1974).

In the clausal model, both the perceptual operations in language comprehension and the representation that the listener assigns a sentence are closely tied to the grammatical structure of the sentence. Since grammatical structure is invariant across discourse contexts, it is not surprising that research in this tradition has tended to ignore discourse variables.

The clausal model followed from research that examined the processing of individual sentences extracted from their natural discourse contexts. Research on discourse processing has instead emphasized the constructive nature of the comprehension process (Bransford, Barclay, & Franks, 1972). The representation that the listener assigns to a sentence in a discourse is assumed to derive not merely from information that is explicitly stated

within the sentence, but also from information provided in the linguistic and extralinguistic contexts, and from listener-generated information derived from knowledge of the world. The representation that is the output of the comprehension process is thought to depend heavily upon inferences which are drawn in order to link propositions in the discourse and fill in missing information. While it is difficult to cast a net around all existing theories of discourse processing, there is general agreement with the following observation by Barclay (1973):

> . . . comprehension is a constructive process in which semantic representations derive from the interplay of sentential information, the context of knowledge to which the information is assimilated, task demands, and the assimilation processes themselves, including interpretive and logical operations. These semantic representations in turn serve as memory representations. (pp. 231-232)

Thus, two different views of the comprehension process emerge. Researchers in the sentence perception tradition have tended to view the initial stages of the comprehension process as closely tied to the grammatical structure of the clause or sentence, and as relatively invariant across contexts. Researchers interested in discourse have assumed that the initial stages in comprehension are heavily influenced by the extended context. Unfortunately, these different points of view are correlated with differences in method; most research on the early stages in processing has examined isolated sentences, ignoring discourse variables, while research on discourse has tended to use memory paradigms that may not reflect the

representations that are initially derived. As a result, we do not have a clear answer to the question: Do discourse variables influence processes involved in the immediate analysis of a clause or sentence?

The few studies which have addressed this question have provided equivocal or contradictory results. Many of these studies involve the processing of ambiguous utterances. Bever, Garrett, and Hurtig (1973) presented subjects with complete and incomplete clauses that were structurally ambiguous (e.g., Although the solution was clear . . .). The subjects' task was to produce a continuation which formed a complete sentence. Sentence completion times were longer for ambiguous fragments compared with unambiguous fragments only when they were incomplete clauses. Bever et al. argued that these results were obtained because listeners compute multiple readings of ambiguous fragments and select one at the clause boundary. Following incomplete ambiguous clauses, subjects had to choose between two alternate readings before completing the sentence. Following complete clauses, only one reading was available, and no choice was required. Hurtig (1978) found that this difference between clause types also obtained when the ambiguous stimuli were placed in discourse contexts which were biased toward one reading. He concluded that clausal processing strategies are not influenced by discourse context. Tyler and Marslen-Wilson (1977) presented listeners with structurally ambiguous fragments such as flying planes preceded by a clause that biased one reading (e.g., If you walk too near a runway or Even if you are a trained pilot). Each fragment was

followed by a target word, either is or are, which was presented visually. The context clause determined whether is or are was the grammatical continuation of the phrase flying planes. Reaction times to read the target word were faster when the word was a contextually appropriate continuation, suggesting that listeners were making use of the context prior to the clause boundary. Thus the Hurtig (1978) and Tyler and Marslen-Wilson (1977) studies lead to opposite conclusions about the role of context on within-clause processing.[1]

A closely related issue concerns when in the comprehension process listeners and readers draw inferences that link explicitly stated information. In a sequence such as (1), the listener or reader must infer that the beer refers to the picnic supplies mentioned earlier.

(1) Horace got some picnic supplies out of the car. The beer was warm.

(2) Horace got some beer out of the car. The beer was warm.

In (2), however, no inference is required, since the antecedent is explicitly stated. According to a model in which within-sentence processing proceeds without regard to discourse context, the listener would assign an initial representation to the sentence The beer was warm in (1), and then seek a referent for the definite noun phrase. The same initial representation would also be assigned in (2), where no subsequent search is required. In contrast, a model in which context can affect within-sentence processing might predict that listeners attempt to establish a referent for the definite

noun phrase immediately after it is encountered, rather than waiting for the end of a major grammatical unit. On this view, The beer was warm is assigned different initial representations in (1) and (2).

Haviland and Clark (1974) examined comprehension times for target sentences beginning with definite noun phrases (such as The beer was warm) when preceded by a context sentence which either provided a direct antecedent, as in (2), or required an inference, as in (1). Comprehension times were longer when the inference was required. Haviland and Clark proposed that on encountering a definite noun phrase, the listener immediately searches memory for an antecedent. If none is found, an inference is drawn in order to establish one.

Haviland and Clark's results established that listeners generate linking inferences and that this process can take time. However, these results do not reveal when in the sequence of processing events such inferences are generated. In particular, Haviland and Clark's results are also consistent with models such as Hurtig (1978) and Fodor, Fodor, and Garrett (1975), in which linking inferences are not made until the end of a clause or sentence. Similar arguments hold for other studies (e.g., Carpenter & Just, 1977; Kintsch & Keenan, 1973) which demonstrate that inferences are made in the comprehension of text or discourse.

The present article addresses two questions concerning the influence of discourse context on sentence processing: (a) Does context influence clausal processing strategies? And (b) do listeners make certain types of context-based inferences prior to the end of a sentence? These two

questions provide a natural starting point for an investigation of the influence of discourse context on sentence perception, given the importance of clausal processing and inferencing in current comprehension models.

Experiment 1

A great deal of research has concentrated on identifying the major processing unit in sentence perception. A guiding assumption has been that this unit must correspond to a theoretically defined linguistic structure. Various candidates have included phrases, surface structure clauses, and clauses corresponding to deep structure sentences (for review, see Carroll, Tanenhaus, & Bever, 1978). However, Tanenhaus and Carroll (1975) suggested that whether or not a syntactically well-defined clause functions as a processing unit depends on a set of additional factors. Under their "functional clause" hypothesis, clauses which contain a complete and fully specified set of grammatical relations, such as (3), function as better processing units than clauses with deleted or unspecified grammatical relations, such as (4-5).

(3) After the tall boy returned home, ...

(4) After he returned home, ...

(5) After returning home, ...

Carroll et al. (1978) reviewed a number of recent studies that support their hypothesis. For example, Marslen-Wilson, Tyler, and Seidenberg (1978) showed that clauses with specified noun phrase subjects are better

processing units than clauses with pronoun subjects. They presented subjects with a cue word followed by a biclausal sentence which began with a clause containing either a pronoun or a specific noun. The subjects' task was to monitor the sentence for a word which either rhymed with or was a category exemplar of the cue word (rhyme and category monitoring). For example, if the target word was CAT, the cue was either BAT or ANIMAL. Targets were either the final word in the first clause or the initial word in the second clause. Performance on the two tasks was similar. For clause-final targets, monitor latencies showed no difference for the two types of clauses. For targets in the second clause, monitor latencies were faster following clauses with pronouns, suggesting that the clauses had not functioned as processing units. Similar results were reported by Carroll and Tanenhaus (1978).

These experiments suggest that clauses with unspecified information are poorer processing units than clauses in which all information is fully specified. Note, however, that in normal discourse, clauses with unspecified information are often preceded by contexts that provide the missing information. Experiment 1 used the rhyme monitor task to investigate whether clauses containing pronouns become better processing units in contexts that provide antecedents. Subjects heard two-clause sentences in which the subject of the first clause was either specified (6a) or pronominal (6b). Following Marslen-Wilson et al. (1978), these will be termed <u>determinate</u> and <u>indeterminate</u>, respectively. Each target

sentence appeared with two context sentences, which either provided an antecedent for the pronoun (informative contexts such as 7a) or did not (neutral contexts such as 7b).

Targets:

(6a) When parents are cruel, kids often become delinquent.

(6b) When they are cruel, kids often become delinquent.

Contexts:

(7a) Some parents can be extremely insensitive.

(7b) There is one thing I learned in my sociology class.

The rhyme word was always the first word of the second clause in the second sentence (e.g., KIDS). In neutral contexts, monitor times should be faster following indeterminate clauses compared to determinate clauses, as in the Marslen-Wilson et al. (1978) study, for two reasons. First, the indeterminate clauses create the expectation that certain information will be forthcoming, in particular, information that will fill the slot created for the referent of the subject pronoun (Sidner, 1979). Thus, the listener is actively seeking missing information, and the context can be used in a predictive or top-down manner, facilitating subsequent decoding (Fischler & Bloom, 1979). This will not occur in the determinate clauses, where there are no empty slots and little information is provided concerning the initial noun phrase of the second clause. Second, information in the indeterminate clauses will be more accessible to the listener, a fact which may also facilitate continued processing of the input. Because they contain an explicit subject, verb,

and object, determinate clauses will be recoded, which, in the clausal processing model, results in removal from working memory and loss of surface-level information (Fodor, Bever, & Garrett, 1974). Indeterminate clauses cannot be recoded because the subject is missing; hence, their literal form remains directly accessible in working memory.

With informative contexts, the facilitation in rhyme detection following indeterminate clauses should be eliminated if listeners are able to use the information in the context sentence to assign the pronoun a referent prior to completion of the clause. That is, both determinate and indeterminate clauses should function alike in informative contexts.

Method

Subject. Thirty-two members of the Columbia University community served as subjects and were paid $3.50.

Materials. Twenty sets of two-sentence discourses were derived from sentences such as (6-7). Each set contained four discourses: (a) a neutral context sentence followed by a sentence beginning with a determinate clause; (b) a neutral context sentence followed by a sentence beginning with an indeterminate clause; (c) an informative context sentence followed by a sentence beginning with a determinate clause; and (d) an informative context sentence followed by a sentence beginning with an indeterminate clause. This yielded 80 test stimuli.

Four presentation versions were generated from these discourses and arranged into a modified Latin Square. Each presentation version

contained one discourse from each set. There were five examples of each type of discourse per presentation version. Discourses taken from a particular set maintained the same serial position across presentation versions. Each subject heard 20 test items and 30 filler discourses added to vary the structure of the stimuli.

Each set was assigned a one-syllable cue word that rhymed with the first word of the second clause in the target sentence (hereafter, the target word). For the filler discourses, the position of the target word was varied within the first and second sentences.

The presentation versions were recorded with normal intonation on one track of a stereo tape. The sequence of events on a trial was as follows: cue word, 5-sec pause, context sentence, 2-sec pause, sentence containing target. A timing tone was placed on the other channel of the tape at the beginning of the target word.

Procedure. Each subject was randomly assigned to one presentation version. Subjects heard the stimuli binaurally through stereo headphones. Their task was to monitor each sentence pair for a word which rhymed with the cue word. In order to make sure that subjects attended to the meaning of the sentences, they were required to paraphrase each sentence pair after it was heard. The timing tone, which was inaudible to the subject, started a millisecond timer which stopped when the subject pressed a telegraph key indicating detection of the rhyme.

Results and Discussion

The 32 subjects and 20 experimental trials generated a total of 640 possible rhyme monitor times. Ten times were eliminated from the analysis either because the subject failed to detect the word or because the monitor times exceeded 1.5 sec. Mean monitor latencies for each condition are presented in Table 1. The results were analyzed using an ANOVA with

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Insert Table 1 about here.

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clause type and context type as factors. Separate ANOVAs were performed using subjects and discourse sets as random factors. Both analyses revealed a clause type by context type interaction, $F(1,28) = 4.84$, $p < .05$, in the subject analysis, and $F(1,18) = 4.26$, $p < .06$, in the item analysis. The interactions obtained because monitor times were 39 msec faster following clauses with pronouns than clauses with referential nouns in the neutral contexts. This difference was significant in the subject analysis, $F(1,31) = 6.44$, $p < .025$, and in the item analysis, $F(1,19) = 4.97$, $p < .05$. With informative contexts, latencies following determinate and indeterminate clauses did not differ significantly. These results suggest that clauses with pronouns are poorer processing units than clauses with referential nouns only in contexts which do not supply a referent for the pronoun.

If indeterminate clauses become better processing units when the referent of the pronoun is specified in the preceding context, rhyming latencies for indeterminate clauses in informative contexts should be

longer than in neutral contexts. This pattern of results obtained; however, the 19-msec difference did not approach significance. An examination of the stimulus materials suggested a possible explanation. For several of the sets, the target word seems to be more predictable in the informative context than in the neutral context. Examples are given in (8) and (9). The first sentence in each pair is the informative context, and the target word is presented in parentheses.

(8a) Now and then, everyone likes a few drinks.

(8b) Some things are guaranteed to draw a crowd. (bars)

(9a) The tracks on the Penn Central are in terrible shape.

(9b) Commuters are frequently delayed. (trains)

If subjects were able to predict the target word given the informative context, monitor times would be faster in general following informative contexts than neutral contexts. This would explain the absence of a significant increase in monitor times in clauses with pronouns in informative compared to neutral contexts.[2] It would also explain why monitor times following clauses with referential nouns were faster in informative contexts than in neutral contexts. This 31-msec difference approached significance in the subject analysis, $F(1,31) = 3.99$, and in the item analysis, $F(1,19) = 3.30$.

In order to determine whether the target words were more predictable in informative than neutral contexts, 30 subjects were given each cue word

followed by either the informative or neutral context sentence. Their task was to try to use the context sentence to generate a word that rhymed with the cue word. The type of context given for each of the 20 sentence sets was counterbalanced across two groups of subjects (15 in each group). For the informative contexts, 44% of the rhymes generated by the subject were the same as the target word used in Experiment 1, as compared to 39% for the neutral contexts. On the basis of these estimates of predictability, the 20 sentence sets were divided into three groups: (a) seven sets in which the target word was at least 15% more predictable, in the informative context than in the neutral context; (b) five sets in which the target word was 15% more predictable, in the informative context than in the neutral context; (b) five sets in which the target word was 15% more predictable in the neutral context; and (c) eight sets in which the target word was equally predictable in both contexts. Mean monitor latencies for each of these three groups are presented in Table 2.

Insert Table 2 about here.

When the target word was equally predictable, monitor latencies in neutral contexts were faster following indeterminate clauses than determinate ones. In the informative contexts, however, monitor times were longer following indeterminate clauses. Furthermore, monitor times following indeterminate clauses were 65 msec longer in informative contexts

than in neutral contexts. Thus when the informative and neutral contexts were equated for predictability, monitor times following clauses with pronouns were longer in informative than in neutral contexts, as predicted. Experiment 2 attempted to replicate this result with a larger sample of items in which the target word was equated for predictability in the neutral and informative contexts.

Experiment 2

Method

Subjects. The subjects were 34 members of the Columbia University community who were paid $3.50 for participating.

Materials. The experimental materials consisted of two presentation versions, each containing 40 two-sentence discourses. Twenty-six of these were filler discourses. The experimental discourses were modified from the materials used in Experiment 1.

Each target sentence was paired with both neutral and informative contexts (e.g., sentence [6b] was paired with [7a] and [7b]); subjects heard one of the two resulting discourses. The matched discourses were assigned to the same serial position in the two presentation versions. All stimuli were recorded with normal intonation. Each discourse began with a cue word followed by a 5-sec pause and then the two sentences separated by a 2-sec pause. Other aspects of the procedure were identical to those followed in Experiment 1.

Results and Discussion

With 34 subjects and 14 targets, there were a total of 476 possible monitor times. Seventeen scores were eliminated either because the subject failed to detect the target word or because the monitor times exceeded 1.5 sec. The mean monitor latency was 450 msec in the neutral contexts as compared to 498 msec in the informative contexts. This difference was significant in ANOVAs conducted with subjects and items as random factors, $F(1,32) = 11.28$, $p < .01$, and $F(1,23) = 5.40$, $p < .05$, respectively.

The combined results of Experiments 1 and 2 suggest that the information within a clause plays a role in determining the extent to which the clause will be treated as a perceptual unit. Clauses containing referential nouns (determinate clauses) functioned as better processing units than clauses with pronouns (indeterminate clauses). The results indicate that listeners use contextual information while processing a subsequent clause, since indeterminate clauses were processed in the manner of determinate clauses when preceded by contexts which provided a referent.

Haviland and Clark's (1974) given-new strategy provides one possible characterization of these results. After encountering a pronoun, listeners search working memory for possible antecedents. If they find an antecedent, the clause can be fully processed. If no antecedent is found, however, the listener may maintain the clause in working memory until an antecedent is found later in the sentence or discourse.

Pronouns are not the only structural devices in language which may lead the comprehender to search memory for antecedents. In English, definite articles are generally used when the following noun has been previously introduced in the discourse (e.g., "Harry liked the cat."). The referent of the noun phrase may be explicitly stated in the preceding context; often, however, the listener must infer the antecedent on the basis of extra-linguistic contextual information and previous knowledge. The latter cases require what Clark (1975) has labeled bridging inferences. Experiment 3 investigated when in the comprehension process these inferences are generated.

Experiment 3

We sought to determine if listeners would make bridging inferences immediately following a definite noun phrase or if bridging would be postponed until the end of the sentence containing the definite noun phrase. The materials were modified from those used by Haviland and Clark (1974). Two types of target sentences were used: target sentences beginning with a definite noun phrase (such as those used by Haviland and Clark) and target sentences ending with a definite noun phrase. A sample pair of target sentences is given in (10). The definite noun phrase is underlined.

(10a) The murderer was one of John's friends.

(10b) One of John's friends was the murderer.

(11a) John was murdered yesterday.

(11b) John died yesterday.

Based on Haviland and Clark's work, comprehension times to target sentences should be faster when the sentences are preceded by direct antecedent contexts such as (11a) than when they are preceded by indirect antecedent contexts such as (11b). The question of primary interest here is the relative magnitude of this context effect for the noun-phrase-initial and noun-phrase-final target sentences. If listeners do not begin making the linking inference until they have finished constructing a linguistic representation for the entire target sentence, there should be no difference in the magnitude of the context effect for the two types of target sentences. If, however, listeners begin to make the linking inference as soon as they have encoded the definite noun phrase, the context effect should be smaller when the definite noun phrase comes at the beginning of the sentence than when it comes at the end of the sentence.

Method

Subjects. The subjects were 32 students from the Columbia University community who were paid $3.50 for participating.

Materials. Thirty-two pairs of target sentences containing a definite noun phrase were constructed. In one member of each pair, the sentence began with a definite noun phrase (e.g., 10a) and in the other member, the sentence ended with a definite noun phrase (10b). Sentences in each pair were semantically similar. Two contexts were constructed for each of the sentence pairs. The direct antecedent context provided an antecedent for the definite noun phrase in the target sentence (11a),

while the indirect antecedent context required the subject to make an inference in order to integrate the context and target sentence (11b).

Each set of two context sentences and two target sentences yielded four possible two sentence pairs: (a) a direct antecedent context followed by a sentence beginning with a definite noun phrase; (b) a direct antecedent context followed by a sentence ending with a definite noun phrase; (c) an indirect antecedent context followed by a sentence beginning with a definite noun phrase; and (d) an indirect antecedent context followed by a sentence ending with a definite noun phrase. Four presentation versions, each containing 32 two-sentence discourses, were constructed by assigning the four sentence pairs from the same set to different presentation versions. This resulted in eight exemplars of each condition in each presentation version.

Procedure. Each subject was assigned to one presentation version. Subjects heard the sentences binaurally over stereo headphones and were instructed to press a key following the end of each sentence pair when they understood the two sentences. A timing tone at the end of the second sentence started a millisecond timer which stopped when the subject pressed a telegraph key.

Results and Discussion

The 28 subjects generated a total of 896 reaction times. Due to a mistake in recording, one item was eliminated, leaving 868 comprehension

times. Seven of these times were lost either due to mechanical failure or experimenter error. The results are presented in Table 3. In direct

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Insert Table 3 about here.

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antecedent contexts, comprehension times were similar for target sentences in which the noun phrase came early and sentences in which the noun phrase came late. Comprehension times were longer for both types of target sentences when the context did not provide a direct antecedent and thus required an inference. This inference effect was larger when the definite noun phrase came at the end of the target sentence.

This pattern of results was reflected in a main effect of context in an ANOVA treating subjects as a random factor, $F(1,30) = 23.22$, $p < .01$, and in an ANOVA treating items as a random factor, $F(1,30) = 7.10$, $p < .025$. The effect of target sentence type was significant in the subject analysis, $F(1,24) = 5.97$, $p < .025$, but not in the item analysis, $F(1,30) = 1.05$. Finally, the context by target sentence interaction was significant in the subject analysis, $F(1,24) = 12.47$, $p < .001$; however, it was only a trend in the item analysis, $F(1,30) = 3.16$.

Planned comparisons indicated that the effect of sentence type was due to the 65-msec difference between the noun-phrase-initial and noun-phrase-final sentences in the indirect antecedent contexts. This difference was significant in the subject analysis, $F(1,27) = 24.44$, $p < .001$, and in the item analysis, $F(1,30) = 5.55$, $p < .05$. The context effect

was primarily due to the difference between the noun-phrase-final sentences in the direct and indirect antecedent contexts. This difference was significant in the subject analysis, $F(1,27) = 54.36$, $p < .001$, and in the item analysis, $F(1,30) = 13.16$, $p < .005$. The 32-msec difference between the noun-phrase-initial sentences in the direct and the indirect antecedent contexts was significant in the subject analysis, $F(1,27) = 5.9$, $p < .05$, but not in the item analysis, $F(1,30) = 1.36$.

The results are in good overall agreement with Haviland and Clark's account of how listeners retrieve or construct antecedents for definite noun phrases. The overall effect of context indicated that listeners are making a linking inference when the context did not provide a direct antecedent for the definite noun phrase in the target sentence. The context by sentence type interaction was due to the inference effect being smaller when the noun phrase came early in the target sentence. This suggests that listeners began to make linking inferences as soon as they encountered the definite noun phrases.

There were, however, several aspects of the data which deserve comment. First, the context by target sentence interaction was only a trend in the item analysis, while the difference between comprehension times to noun-phrase-initial sentences in direct and indirect antecedent contexts was significant only in the subject analysis. Thus, the results can only tentatively be generalized to a new population of materials.

The weakness of the item analyses compared to the subject analysis probably reflects the fact that the type and difficulty of the inferences

required in the sentence sets varied. There are no process-oriented taxonomies of different classes of inferences presently available, although work by Clark (1975) and Hildyard and Olson (1978) is a step in this direction. In addition, there has been relatively little research on the difficulty of various inferences types. Given this situation, it is likely that our materials did not form a completely homogeneous set.

Finally, the magnitude of the difference between comprehension times of noun-phrase-initial sentences in direct and indirect antecedent contexts was relatively small compared to the difference observed by Haviland and Clark. There are two possible explanations. Some of the difference is probably due to the fact that we measured comprehension times from the end of the target sentence, while Haviland and Clark measured comprehension time to read and understand the entire target sentence. As a result, our comprehension times were nearly a full second faster than Haviland and Clark's. A more interesting possibility relates to the fact that we used auditory presentation while Haviland and Clark used visual presentation. With visual presentation, the reader controls the rate at which information is taken in. With auditory presentation, however, the listener does not. Haviland and Clark's subjects may have waited until completing the inference before reading the remainder of the sentence. With fairly simple inferences such as those required to understand the discourses in this experiment, subjects may have been able to make the inference without interfering with their processing of the remainder of the sentence, particularly when the definite noun phrase came at the beginning of the target sentence.

General Discussion

The present research was conducted to answer two questions about the influence of discourse context on the processing of a subsequent sentence: (a) Can context influence the immediate processing and organization of a subsequent clause? And (b) do listeners make certain types of context-based inferences prior to the end of a sentence? The answer to both questions is clearly affirmative. Experiments 1 and 2 demonstrated that clauses with pronouns become better processing units in contexts that provide a referential antecedent for the pronoun. Experiment 3 demonstrated that listeners begin to make inferences necessary to construct an antecedent for a definite noun phrase prior to the end of a clause or sentence.

These results suggest that there is not an initial point in the comprehension process at which the listener's representation of what has been heard is restricted to information of the type provided by the context-independent description posited by most grammars. Instead, it appears that the initial processing and representation of a sentence in discourse may differ from those of the same sentence presented in isolation. This conclusion is clearly inconsistent with models of comprehension, such as Fodor, Fodor, and Garrett (1975), which propose that there is a temporally distinct stage in initial comprehension in which the listener understands a sentence in terms of the representation assigned to it by a sentence grammar. This represents a further weakening of the relationship between

grammatical theories and models of the comprehension process. The proponents of the derivational theory of complexity (e.g., Miller & McKean, 1964) assumed that linguistic grammars provided an account of both the perceptual processes and memory representations that are the output of the sentence comprehension process. Since then, there has been a consistent weakening of claims about how closely grammars described aspects of the comprehension process (for further discussion, see Fodor, Bever, & Garrett, 1974). The linguistic representation of a sentence may be among the products of comprehension. However, attempts to define a stage in processing or representation which is isomorphic with such linguistic structures have been unsuccessful (Carroll et al., 1978; Seidenberg & Tanenhaus, 1977). The present results suggest that the proposal by Fodor, Fodor, and Garrett (1975) is also likely to be incorrect.

These results have other implications for models of language comprehension. A great deal of research in sentence processing has demonstrated that clauses are important units (Bever, Garrett, & Hurtig, 1973; Hurtig, 1978; Townsend & Bever, 1978). The results of Experiments 1 and 2 suggest that clausal processing strategies can be affected by discourse context. This is not to say, however, that the types of perceptual processes postulated by the clausal model are invalid at the discourse level. In fact, Experiments 1 and 2 demonstrate that the type of "segmentation" postulated by Bever and his colleagues occurs in discourse processing. However, a complete understanding of sentence processing must take into account discourse context.

Investigations of within-sentence processing in discourse may contribute to our understanding of discourse comprehension. An important part of discourse comprehension involves integrating propositions across sentences (Kintsch & van Dijk, 1978). Much of this integration may take place on-line as a sentence is processed. Retrieving antecedents and making linking inferences during the processing of a sentence probably result in related information being integrated and stored together in memory. In support of this conjecture, it is interesting to note that many of the stylistic devices that complicate sentence processing, such as pronominalization, ellipsis, and subordination, seem to facilitate discourse processing and memory.

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Footnotes

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[1] In Hurtig's (1978) study, the biasing information was presented in a context sentence which preceded the fragment, while in Tyler and Marslen-Wilson's (1977) study, the biasing information was in a subordinate clause which was part of the same sentence as the ambiguous fragment. Tanenhaus and Carroll (1975) have proposed that the information in subordinate clauses is maintained in immediate memory to aid integration with the main clause. Supporting evidence comes from Townsend and Bever (1978). This suggests that the disambiguating information would have been more accessible to guide further processing in the Tyler and Marslen-Wilson study than in the Hurtig study.

[2]For most of the sentence sets, the referential noun was closely related to the target word. Thus at first glance, the predictability explanation seems inconsistent with the fact that monitor times were faster following clauses with pronouns than clauses with referential nouns. One possible explanation is that subjects did not have time to use the information in the first clause to predict the target word. Generating predictions takes both time and processing resources (Neely, 1977), and listeners may not have had enough of either available at the time that they encountered the referential noun. The 2-sec pause between the context sentence and the target sentence may have provided subjects with the time to generate a prediction.

Table 1

Results for Experiment 1

Context	Clause Type	Monitoring Latencies in msec
Neutral	Determinate	524
Neutral	Indeterminate	485
Informative	Determinate	493
Informative	Indeterminate	504

Table 2

Predictability Analysis for Experiment 1

Predictability of Target Words in Neutral and Informative Contexts	Context Type	Clause Type	Monitor Latencies in msec
Target word more predictable in informative contexts than neutral contexts (68% compared to 30%)	Neutral	Determinate	522
	Neutral	Indeterminate	498
	Informative	Determinate	448
	Informative	Indeterminate	453
Target word more predictable in neutral than informative contexts (72% compared to 43%)	Neutral	Determinate	487
	Neutral	Indeterminate	483
	Informative	Determinate	521
	Informative	Indeterminate	523
Target word equally predictable in neutral and informative contexts (26% compared to 28%)	Neutral	Determinate	549
	Neutral	Indeterminate	484
	Informative	Determinate	524
	Informative	Indeterminate	529

Table 3

Results for Experiment 3

Context	Position of Definite Noun Phrase	Comprehension time in msec
Direct Antecedent	Sentence-initial	462
Direct Antecedent	Sentence-final	463
Indirect Antecedent	Sentence-initial	493
Indirect Antecedent	Sentence-final	560

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